PRELIMINARY

Technical Information Manual

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MOD. EASY3000/4000
EMBEDDED ASSEMBLY
POWER SUPPLY SYSTEM
MANUAL REV.4

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TABLE OF CONTENTS

1. EASY3000 EMBEDDED ASSEMBLY SYSTEM 5

1.1 FUNCTIONAL DESCRIPTION 5

1.2 THE CAEN MULTICHANNEL POWER SUPPLY SYSTEM OVERVIEW 6

2. THE MOD. A1676A BRANCH CONTROLLER 8

2.1 A1676A BRANCH CONTROLLER OVERVIEW 8

2.2 A1676A FRONT PANEL 9

2.3 A1676A TECHNICAL SPECIFICATIONS 10

2.3.1 A1676A Packaging 10

2.3.2 A1676A Front panel connections 10

2.3.3 A1676A Front panel switches 11

2.3.4 A1676A Front panel displays 11

2.3.5 Control signals 12

2.4 EASY CRATE CONFIGURATION 12

2.4.1 Installation and set up 12

2.4.2 Configuring the crates 12

3. EASY3000 AND EASY4000 CRATES 15

3.1 EASY3000 CRATE OVERVIEW 15

3.2 EASY 3000 CRATE PANEL CONNECTIONS AND DISPLAYS 15

3.2.1 EASY 3000 crate panel second issue 15

3.2.2 EASY 3000 crate panel first issue 16

3.2.3 EASY4000 crate overview 17

3.2.4 A1676A – EASY3000/4000 CRATE connection 18

3.3 48 V POWER SOURCES 21

3.3.1 Mod. A3484 and A3485 AC/DC Converters 21

3.3.2 Mod. A3486 AC/DC Converter for Hostile Areas 21

4. SAFETY INFORMATION AND INSTALLATION REQUIREMENTS 22

4.1 GENERAL SAFETY INFORMATION 22

4.1.1 Injury Precautions 22

4.2 SAFETY TERMS AND SYMBOLS ON THE PRODUCT 22

4.3 INSTALLATION 23

4.4 OPERATING MODES 23

4.5 OUTPUT CONTROL AND MONITORING 23

4.6 INTERLOCK OPERATION 23

LIST OF FIGURES

FIG. 1.1 – SYSTEM'S BLOCK DIAGRAM 6
FIG. 2.1 – MOD. A1676A BRANCH CONTROLLER FRONT PANEL 9
FIG. 2.2 –DSUB50 CONTROL CONNECTOR PIN ASSIGNMENT 11
FIG. 2.3 – EASY RACK BUILDER MAIN MENU 13
FIG. 2.4 – EASY RACK BUILDER WITH POPULATED RACKS 14
FIG. 3.1 – EASY 3000 CRATE PANEL SECOND ISSUE 15
FIG. 3.2 – EASY 3000 CRATE PANEL FIRST ISSUE 16
FIG. 3.3 – EASY4000 CONNECTORS 18
FIG. 3.4 – CONNECTING A1676A AND THE CRATES WITH 50 WIRES CABLE 19
FIG. 3.5 – CONNECTING A1676A AND THE CRATES WITH SPLIT CABLE 20
FIG. 3.6 – A3485 48 V POWER SOURCE FRONT PANEL 21

LIST OF TABLES

TABLE 1.1 – EASY3000/4000 CRATES AND BOARDS HOSTILE AREAS TOLERANCES 5
TABLE 1.2 – TECHNICAL SPECIFICATIONS OF THE SY 1527 MAINFRAME 7
TABLE 2.1 – A1676A CONTROL SIGNALS 12
TABLE 3.1 – EASY 3000 CRATE CONNECTIONS SECOND ISSUE 16
TABLE 3.2 – EASY 3000 CRATE CONNECTIONS FIRST ISSUE 17
TABLE 3.3 – TECHNICAL SPECIFICATIONS OF THE A3484 AND A3485 48 V POWER SOURCES 21
TABLE 3.4 – TECHNICAL SPECIFICATIONS OF THE A3486 48 V POWER SOURCE 21

1. EASY3000 Embedded Assembly System

1.1 Functional description

EASY3000 (Embedded Assembly SYstem) is the new CAEN power supply solution for operation in magnetic field and radioactive environment. CAEN has been involved for more than a decade in developing different solutions for the main LHC experiments, where the electronic equipment of the experiment is dealing with high dose radiation and intense magnetic field. In order to provide safe and reliable operations in such hostile areas, CAEN started tests with rad-tolerant components and magnetic field resistant solutions, patenting the new technology that is now used in this new line of products. Moreover, though designed for harsh environment, the EASY3000 modules can work also in normal condition with excellent performance. In the new architecture, the power supply can be located directly in the hostile area (see Table 1.1), where the EASY3000 modules provide a wide variety of output voltages to satisfy the requirements of most detectors and front-end electronics. The control of the EASY3000 power supply system is done remotely using a Branch Controller (Mod. A1676A) plugged in a SY1527 or SY2527 mainframe located in the control room. Each A1676A branch controller can handle up to 6 EASY3000 crates. The EASY3000 crate can house up to 10 boards, depending on the boards' width. The branch controller is the interface between the mainframe (SY1527 or SY2527) and the remote boards in the EASY3000 crate: its role is to configure the EASY3000 channels as if they belong to the supply unit slot in which the branch controller is located. All the channels of the EASY3000 boards will be considered as channels of the branch controller, thus hugely increasing the number of channels the system can handle. Through the mainframe, the provided and fully reliable OPC server permits an immediate and "automatic" interfacing with the custom control software; moreover, a C-library for Windows and Linux is available as well. The EASY3000 crate can be used with an air and/or water intercooler and its standard width fit the rack mounting. An optional fan tray (A34FU -EASY3000 Fan Unit) can be used for the stand-alone operation of the EASY3000 crate when no magnetic field is present. EASY3000 is powered by external 48 V DC. The EASY architecture foresees two independent 48 V power supplies: the first (48 V Power) to power the channels regulators, the other (48 V Service) to power the control logic. The use of CAEN 48 V power sources (Mod. A3484 and A3485), allows to integrate into the channels control also the management of the 48 V power supplies. Fig. 1.1 shows the system's block diagram.
The EASY4000 crate is designed to house some custom PS boards that do not fit into the EASY3000 crates; it supports mechanically up to 9 PS boards and distributes control signals and power supplies.

Table 1.1 – EASY3000/4000 Crates and Boards hostile areas tolerances

Magnetic field:	2 kGauss
Radiation:	$1 \cdot 10^{11}$ p/cm^2 TD $2 \cdot 10^{12}$ n/cm^2 TD 15 kRad TID

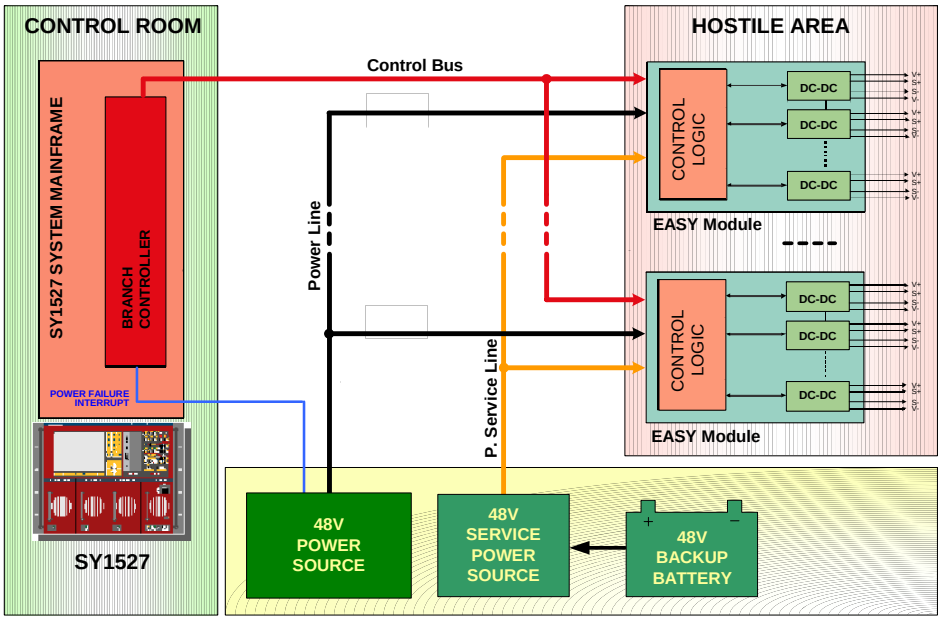

Fig. 1.1 – System's block diagram

1.2 The CAEN Multichannel Power Supply System Overview

The SY1527 system is the fully equipped experiment version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying. This system outlines a completely new approach to power generation and distribution by allowing the housing, in the same mainframe, of a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards (temperature, pressure monitors, etc.) and branch controllers, where the latter are used to control other remote generators and distributors. Modularity, flexibility and reliability are the key-points of its design, enabling this module to meet the requirements needed in a wide range of experimental conditions, which range from those of LHC experiments, where the features of this model find prior application, to those of other less challenging, but still demanding, High Energy Physics experiments.
The mainframe is housed in a 19"-wide, 8U-high euro-mechanics rack and hosts four main sections:

- the Board Section, with 16 slots to house boards, distributors and branch controllers;
- the Fan Tray Section, housing 6 fans arranged on two rows;
- the Power Supply Section, which consists of the primary power supply and up to 3 power supply units;
- the CPU and Front Panel Section which includes all interface facilities.

The User Software Interface features the usual friendliness of the previous CAEN systems which now also includes a 7.7" colour LCD. A wide choice of interface facilities provides full communication compatibility with the previous systems and the feasibility of controlling heterogeneous external devices. Modularity has been one of the leading criteria in the design and development of the system: both the Power Supply Section and the Board Section are completely modular. The Power Supply Section allows different configurations with up to 3 power supply units per mainframe (up to 2250 W), while the Board Section can house up to 16 boards able to fulfil different functions. A complete line of power supply boards and distributors has been specially developed for this new system. The minimum system configuration consists of the primary power supply, one

Power Supply Unit and one board. The system allows also to deal with power supply solutions composed by “branch controllers” (housed in the system main frame) and on-detector “remote boards” (manufactured in order to be magnetic field and radiation tolerant). Channel trip control on other crates is performed via four external differential trip lines. A sophisticated trip handling via software allows to control and correlate trip conditions on the channels of the crate as well as of other crates connected to it. Live insertion and extraction of the boards, which reduces the down time of the global system, and easy access to the computing core and peripherals of the system complete the system flexibility. Easy interfacing is another key-point of the SY1527 system, which can be connected to SY127 and SY527 systems. The Ethernet interface (TCP/IP) allows both an easy Telnet access and the connection via OPC Server to a SCADA control system. Enhanced software programming features a unified command set independent from the interface used to communicate with the system. The Power Supply Section and Board Section can be externally synchronised via front panel connectors. Multi-layered access to the system via Intranet is foreseen through the management of several custom user profiles. In particular, three different access levels have been implemented: Guest, User and Administrator, each of which with password protection. Handy maintenance and upgrading, which constitute a major issue in the reliability of a system, are further guaranteed by the possibility of accessing and servicing the system via network facilities. Actually, the Telnet access facility allows remote debugging and technical support of the system, including future firmware upgrading. For a detailed description of the SY 1527 Universal Multichannel Power Supply System please refer to the *SY 1527 User's Manual*.
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Table 1.2 – Technical specifications of the SY 1527 mainframe

Packaging	- 19"-wide, 8U-high Euro-mechanics rack; - Depth: 720 mm.
Weight	-Mainframe (*): 24 kg -Mod. A1532: 3.2 kg
Power requirements	*Voltage range*: 100/230 V *Frequency*: 50/60 Hz *Power*: 3400 W
Max. number of boards per crate	16
Max. number of power supply units per crate	3
Primary power supply output (Mod. A 1531)	± 12 V, 8 A +5 V, 20 A
Power supply unit output (Mod. A 1532)	+48 V, 15.6 A
Max. output power	2250 W
Operating temperature	From 0°C (dry atmosphere) to +40°C
Storage temperature	From -20°C (dry atmosphere) to +50°C

(*) One Primary Power Supply (Mod. A 1531) and one Power Supply Unit (Mod. A 1532) are included; boards are not included.

2. The Mod. A1676A Branch Controller

2.1 A1676A Branch Controller overview

The Mod. A1676A EASY Branch Controller is implemented in a single width SY1527/SY2527 board. Once plugged in, the Branch Controller must be linked to the EASY3000 and EASY4000 crates (which can work in the “hostile area”), via front panel connectors (Control and Power Supply). The A1676A is the interface between the mainframe and the remote boards in the EASY3000/4000 crate. It configures the EASY3000/4000 channels as if they belong to the slot in which the branch controller is located: the channels of the EASY3000/4000 boards operate as channels of the A1676A. Up to six EASY3000/4000 crates can be controlled by one A1676A.
The User has to configure the A1676A to operate with His EASY crate layout by using the provided software tool (see details in § 2.4).
The A1676A branch controller is a single width board and will be housed in one SY1527 system, while the remote sections will operate in the “hostile area”.

2.2 A1676A Front Panel

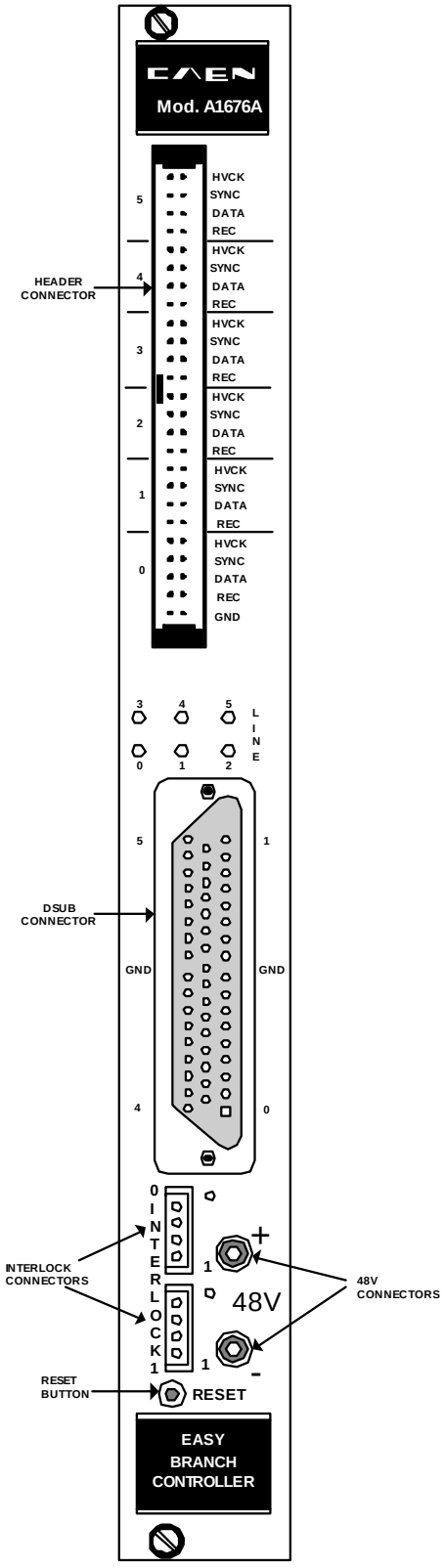

Fig. 2.1 – Mod. A1676A Branch Controller front panel

2.3 A1676A Technical specifications

The A1676A Branch Controller board can control up to six remote crates through the CANbus protocol (250 kbit/sec).
Remote crates controlled by the A1676A can house different sets of EASY3000/4000 boards, then it is necessary to configure the Branch Controller firmware through a set up file containing all the information about number, type and position of the boards in remote crates. After the configuration it is not possible to change the crate layout unless the A1676A configuration file is updated. The Branch Controller, in fact, scans the crates expecting to find the sets of boards corresponding to its configuration file; if any board is misplaced (or absent) with respect to the configuration file, then it is ignored and its channels are signalled as “unplugged” by the SY1527: in this case it is necessary to insert correctly the misplaced board, and then its channels will be accessed.
The User can build his crate configuration using the software tool described in § 2.4.
Control of remote crates is performed through 2 alternative output connectors (50-pin Header male or 50-pin DSUB female) placed on the front panel of the A1676A board (see fig. 2.1); maximum suggested cable length between A1676A and EASY crate is 150 m.
The front panel houses also six green LEDs (one per branch = remote crate); each LED lights up / blink as the branch communications take place.
The Reset button allows to reset the internal A1676A controller; during this operation all the remote channels continue operating with old settings. It is necessary to wait 15 seconds at least before monitoring or setting once more the remote channels.
The Interlock signal allows to shut down all the remote channels, keeping active the communications between remote boards and SY1527[1].
The A1676A provides also a 48 V / 2 A supply voltage (to be used for powering the crates) that can be enabled via the A1676A 48V parameter.

2.3.1 A1676A Packaging

The Mod. A1676A module is housed in a 5 TE-wide, 6U-high mechanics. The board requires one SY1527 slots (single-width).

2.3.2 A1676A Front panel connections

CONTROL Connectors:	50-pin Header male / 50-pin DSUB female
48 V OUT Connector:	2 x 4 mm connectors female
INTERLOCK Connectors:	2 x 4 pin Amp connectors

[1] This feature is not yet implemented

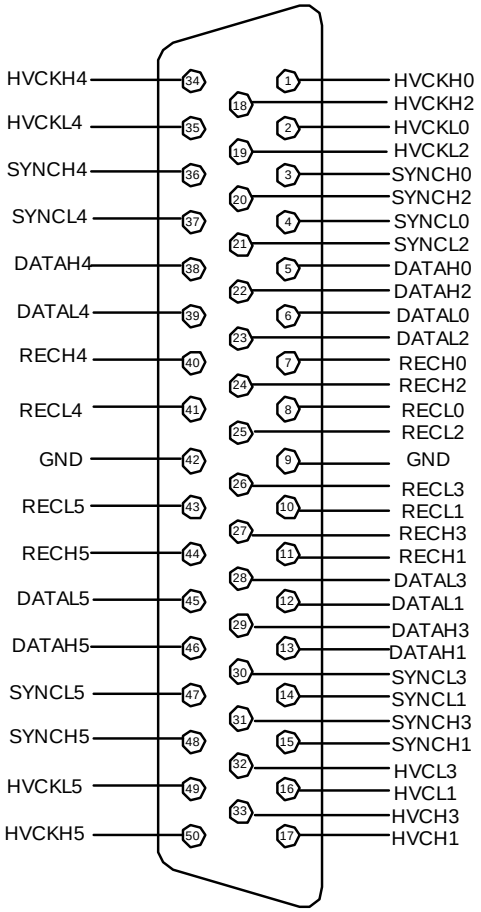

Fig. 2.2 –DSUB50 Control connector pin assignment

2.3.3 A1676A Front panel switches

RESET button: Function: the A1676A is reset but HVCK and SYNC still provided

Type: Monostable push-button

2.3.4 A1676A Front panel displays

LINE LEDs: *Function*: light up the when corresponding branch communicates with A1676A.
Type: green LED.

INTERLOCK LEDs: *Function:* light up when the corresponding interlock input is active[2].
Type: red LED.

[2] This feature is not yet implemented.

2.3.5 Control signals

The Branch Controller Control signals are described in the following table.

Table 2.1 – A1676A Control Signals

SIGNAL	DESCRIPTION
HVCK	625 kHz synchronisation signal (one per branch) for switching parts of remote PS channel boards; however, if this signal fails, remote boards run properly (a synchronisation signal is generated by their controller), though lose synchronisation between each other, and an error message ("Fail") is returned by the SY1527. The HVCK presence is signalled by the remote board parameter "HVSync" (Ok or Fail)
SYNC	50 Hz clock (one per branch) for the board controllers synchronisation; if this signal fails, remote boards do not operate and an error message ("Fail") is returned by the SY1527. In order to remove the Fail message, it is necessary to send the "Clear Alarm" command
DATA	Communication data line
REC	Recovery / Reset lines, one for each remote EASY3000 crate; through the SY1527 it is possible to send a command to the controllers of a remote crate either switching off all the channels in the crate (HW Reset) or eventually leaving them on, if they were (Recovery)

The A1676A Branch Controller allows also to use the SY1527 System front panel signals (Kill, Interlock, Enable) on the remote channels.

2.4 EASY Crate Configuration

CAEN EASY Rack Builder is a Java(TM) application which allows EASY Users to create their customised EASY Crate configurations.

2.4.1 Installation and set up

First of all it is necessary to connect the PC, which must run a Java(TM) 2 Platform Standard Edition, and must be connected to the Internet.
Now it is necessary to download the software tool from the web page:
http://www.caen.it/nuclear/product.php?mod=A1676A
Click on the *Software* menu and download the *CaenEASYRackBuilder.zip* file
Unzip the file then launch the *CaenEASYRackBuilder.jar* Java(TM) application

2.4.2 Configuring the crates

Now the following EASY Rack Builder window will open:

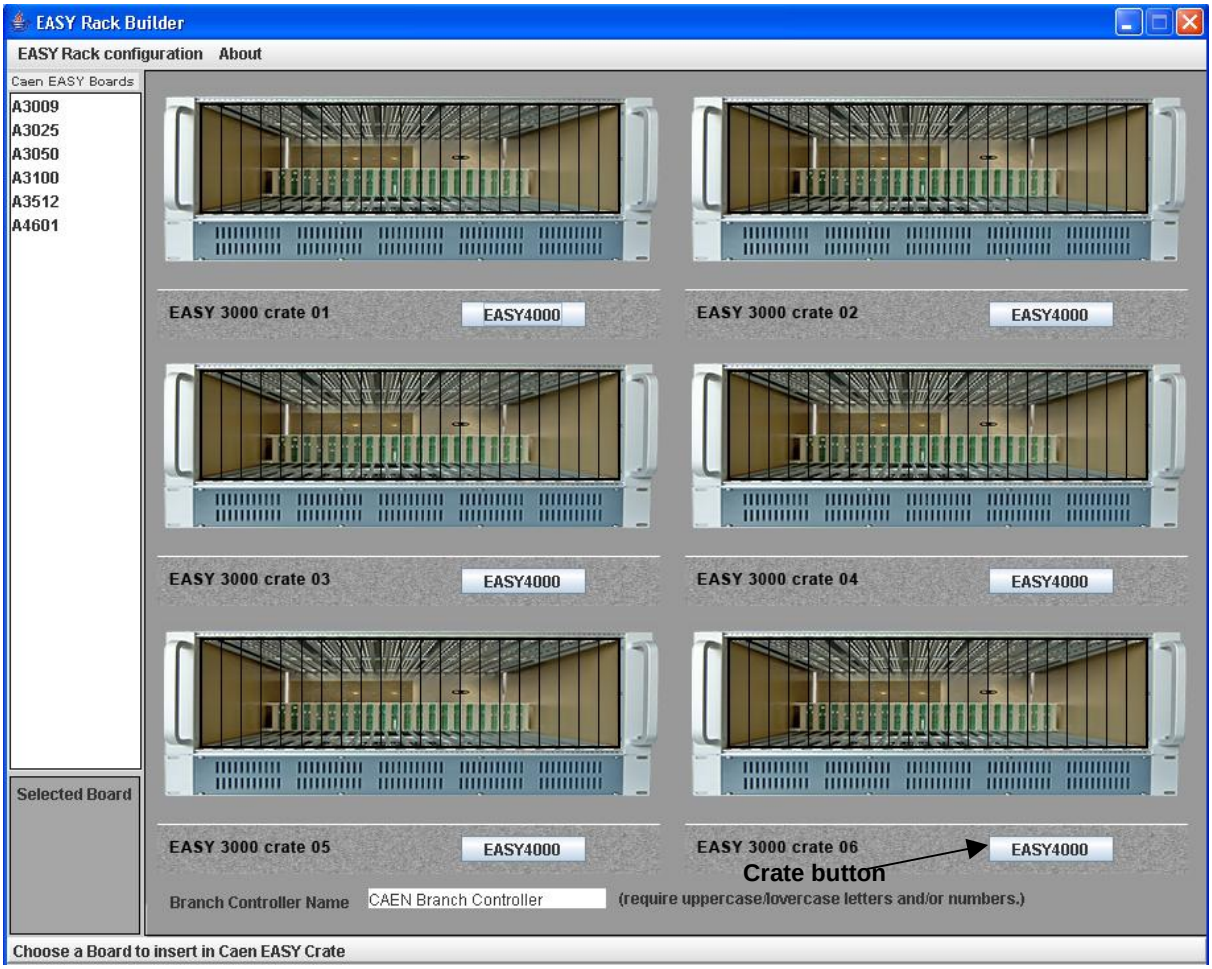

Fig. 2.3 – EASY Rack Builder main menu

The EASY Rack Builder shows six empty EASY crates, by clicking on the “Crate button” it is possible to choose between EASY3000 and EASY4000 crates (according to the crates connected to the A1676A to be configured).
The menu on the white box on the left lists the EASY boards available to fill the crates.
The operating parameters of such boards are stored in the *board.xml* files included in the folder:
\CaenEASYRackBuilder\Boards
Each time CAEN EASY Rack Builder is launched, such xml files are compared to those present in the CAEN data base and, if the comparison is successful, the corresponding boards are added in the white box list.
The updated xml files of each board can be downloaded at:
http://www.caen.it/nuclear/product.php?mod=XXXXX
where “XXXXX” stands for the board name (for example: *A3009*).
In order to configure the crates it is necessary to select the desired board by double clicking on its name and dragging it on the selected crate slot. Double click again to drop.
Boards can be removed from the crates double clicking on them and dragging and dropping them on the white box.

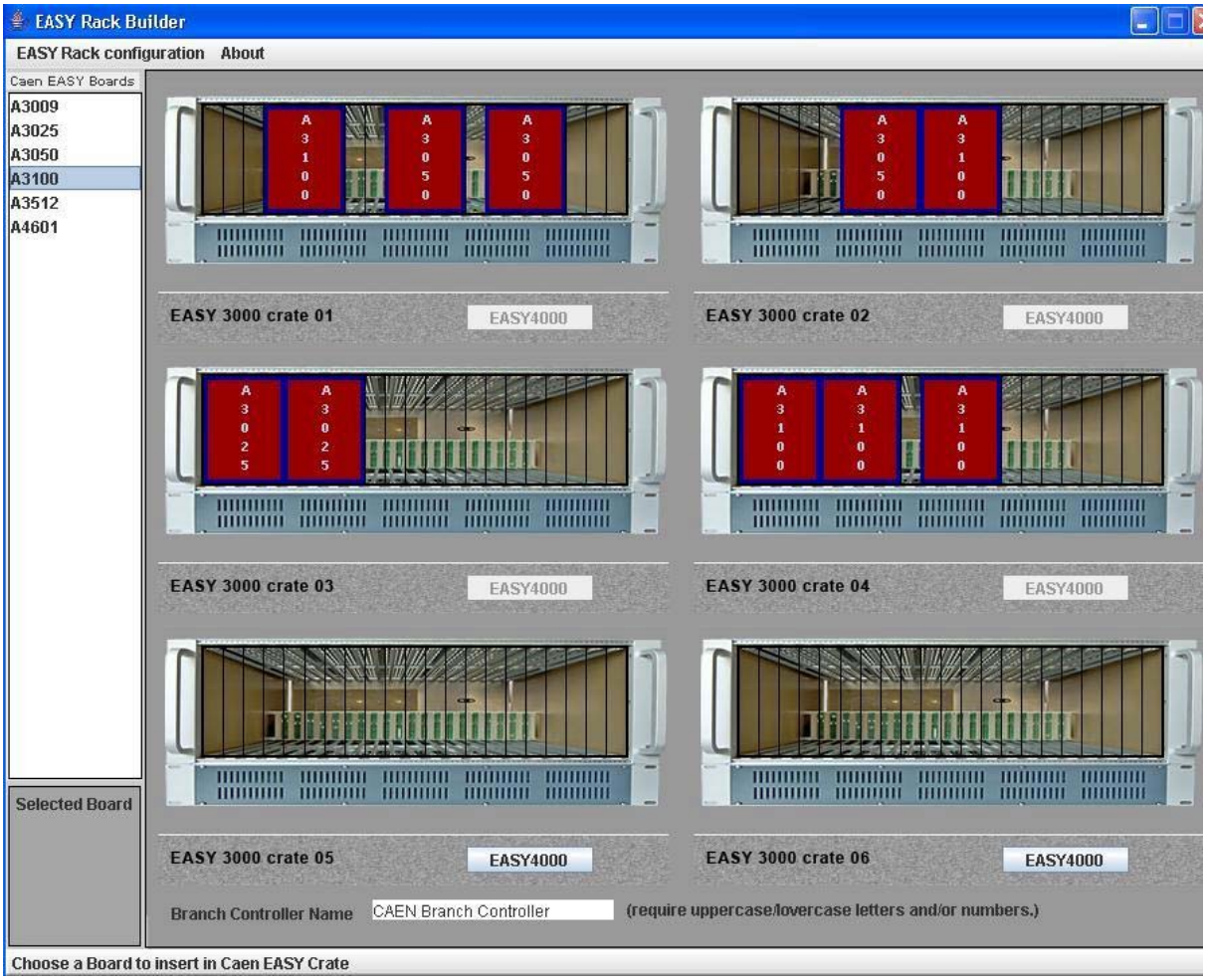

Fig. 2.4 – EASY Rack Builder with populated racks

When the crate configuration is done it is necessary to save the file; go to:

EASY Rack Configuration > Save as…

This allow to create an xml file which can be used for future purposes (modify, update etc.).

In order to configure the A1676A it is necessary to select:

EASY Rack Configuration > Generate Branch Controller update file

This allow to create a binary file that must be used to configure the A1676A via SY1527; now it is necessary to connect the PC to the SY1527 System which hosts the A1676A to be configured. The configuration procedure is described in the SY1527 User Manual, section 7.1.19 (*The UTILITY Menu: Board Upgrade*).

3. EASY3000 and EASY4000 crates

3.1 EASY3000 crate overview

The EASY3000 crate is designed to house Power Supply and ADC boards of EASY3000 family; it supports mechanically EASY boards and distributes control signals and power supplies. It is handled by one of six branches of the A1676A – Branch Controller.

3.2 EASY 3000 crate panel connections and displays

3.2.1 EASY 3000 crate panel second issue

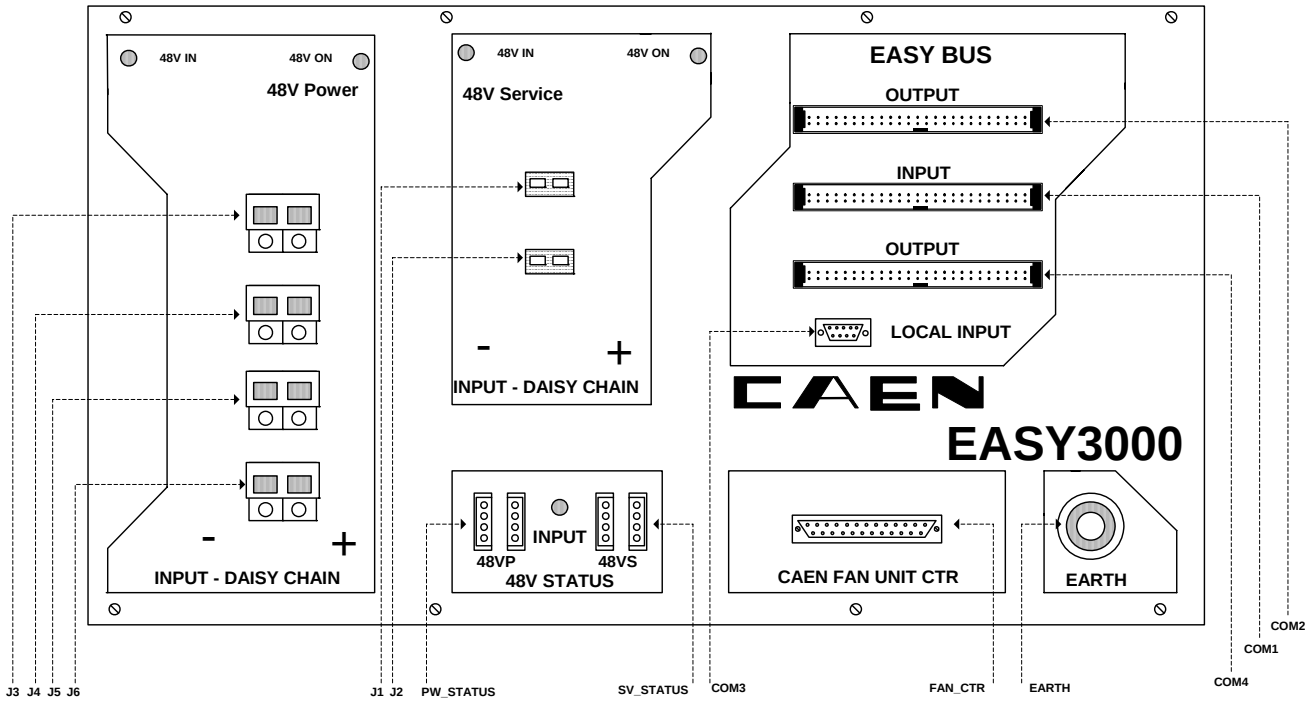

Fig. 3.1 – EASY 3000 crate panel second issue

Fig. 3.1 shows the EASY 3000 crate panel second issue and subesquents; the connections are explained in the following table:

Table 3.1 – EASY 3000 crate connections second issue

Name	Description
J1,J2	48V SERVICE connectors (in parallel); input of 48 V supply for auxiliary low voltages in boards
J3..6	48V POWER connectors (in parallel); input of 48 V supply for DC/DC converters
F2	100 Amps fuse on 48 V POWER line
Com1..4	I/O of EASY bus for remote control
48V power/service status[3]:	Connectors for inputs from 48V supplies. Through this input the remote EASY board microcontroller can detect failures in supply voltages and consequently enables PS channels ramping down, while service supply voltage is provided by a back up battery
FAN_CTR	Control link for fan unit
EARTH	Earth link for the crate

3.2.2 EASY 3000 crate panel first issue

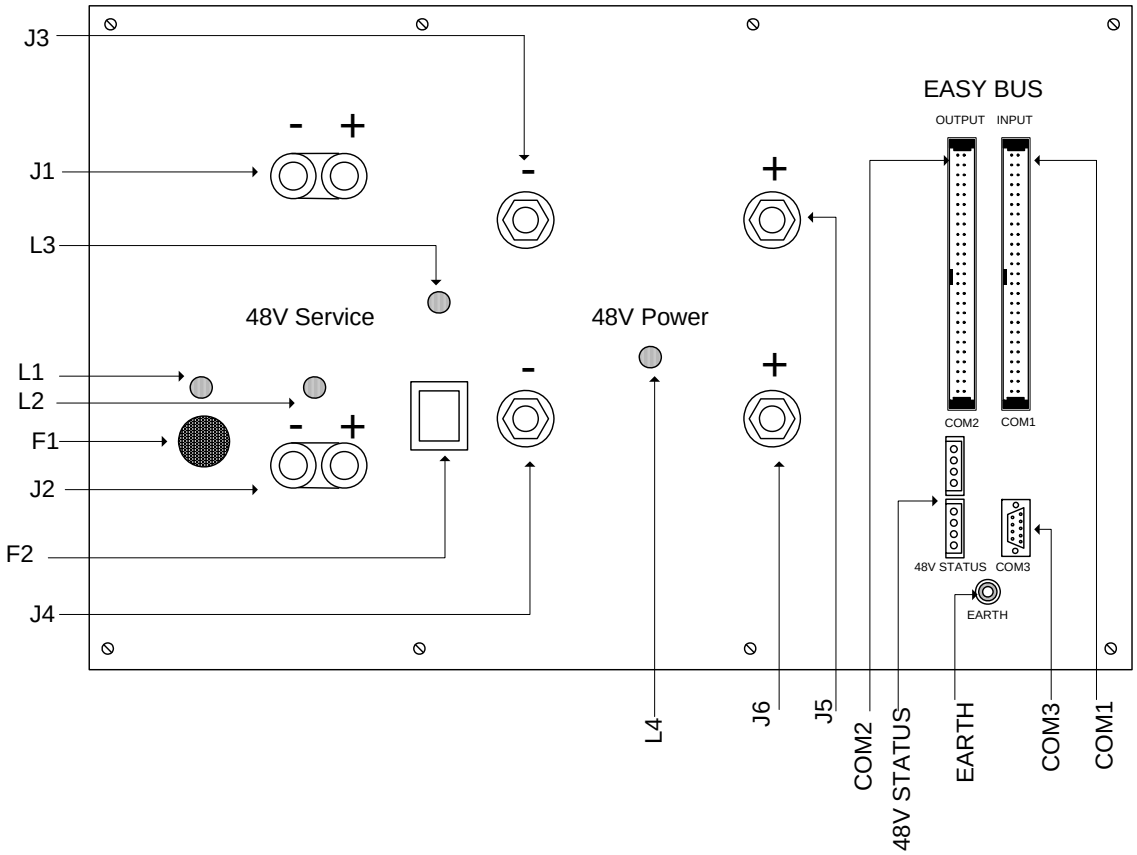

Fig. 3.2 – EASY 3000 crate panel first issue

[3] This feature is not yet implemented

Fig. 3.2 shows the EASY 3000 crate panel first issue; the connections are explained in the following table:

Table 3.2 – EASY 3000 crate first issue connections

Name	Description
J1,J2	48V SERVICE connectors (in parallel); input of 48 V supply for auxiliary low voltages in boards
F1	20 Amps fuse on 48 V SERVICE line
L1	Red LED that lights up when F1 is interrupted
L2	Red LED that lights up when 48 V SERVICE is present
J3, J4, J5, J6	48V POWER connectors (in parallel); input of 48 V supply for DC/DC converters
F2	100 Amps fuse on 48 V POWER line
L3	Red LED that lights up when F2 is interrupted
L4	Red LED that lights up when 48 V POWER is present
Com1, Com2, Com3	I/O of EASY bus for remote control
48V status[4]:	Connectors for inputs from 48V supplies. Through this input the remote EASY board microcontroller can detect failures in supply voltages and consequently enables PS channels ramping down, while service supply voltage is provided by a back up battery
EARTH	Earth link for the crate

3.2.3 EASY4000 crate overview

The EASY4000 crate is designed to house some custom PS boards that do not fit into the EASY3000 crates; it supports mechanically up to 9 PS boards and distributes control signals and power supplies. The crate has ten slots: slot 0 (the leftmost) is available for test purposes, while slot 1..9 are suitable to host PS boards. The EASY4000 crate is handled by one of six branches of the A1676A – Branch Controller. The crate panel is provided with I/O 50 pin flat connectors of the EASY bus remote control and the 48V Status input connector which allows the PS boards microcontrollers to detect failures in supply voltages and consequently to enable PS channels ramping down, while service supply voltage is provided by a back up battery; a green led signals the 48V activity. An Earth link for the crate is available as well.

[4] This feature is not yet implemented

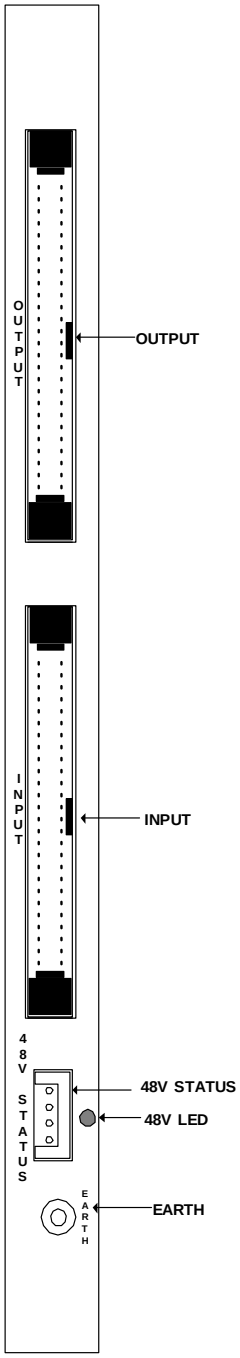

Fig. 3.3 – EASY4000 Connectors

3.2.4 A1676A – EASY3000/4000 CRATE connection

There are two different ways for connecting the A1676A Branch controller with up to six EASY3000/4000 crates; the first type of connection uses a 50-wires flat cable between the A1676A and the first crate as well as between the subsequent crates, as shown in the following figure:

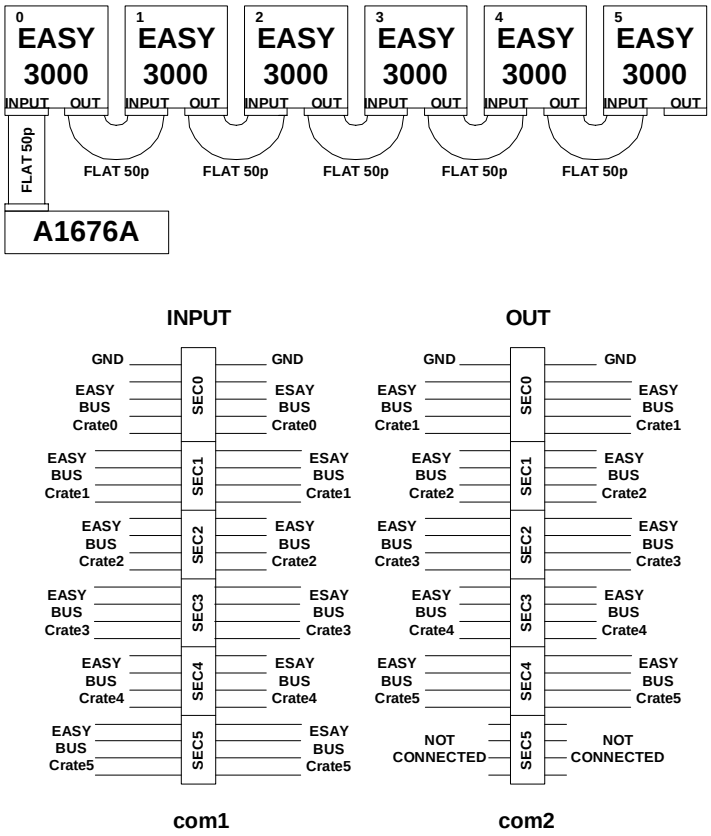

Fig. 3.4 – Connecting A1676A and the crates with 50 wires cable

The A1676A provides the signals for all the crates; the first crate uses only “Section 0” (see § 2.2) of such control signals arriving into the input connector and passes the other sections to its output connector. Each EASY 3000/4000 crate is connected in series to the subsequent other ones.
The main advantage of this way of connection is the easy manufacturing of cables.
The most evident disadvantage is the unnecessary connection of each crate with 50 wires, while only 4 couples and return would be required.

The second way of connection uses the DSUB50 control connector of the A1676A, which, via a split cable, is connected with each section of the EASY BUS through the crates DB9 connectors, as shown in the following figure:

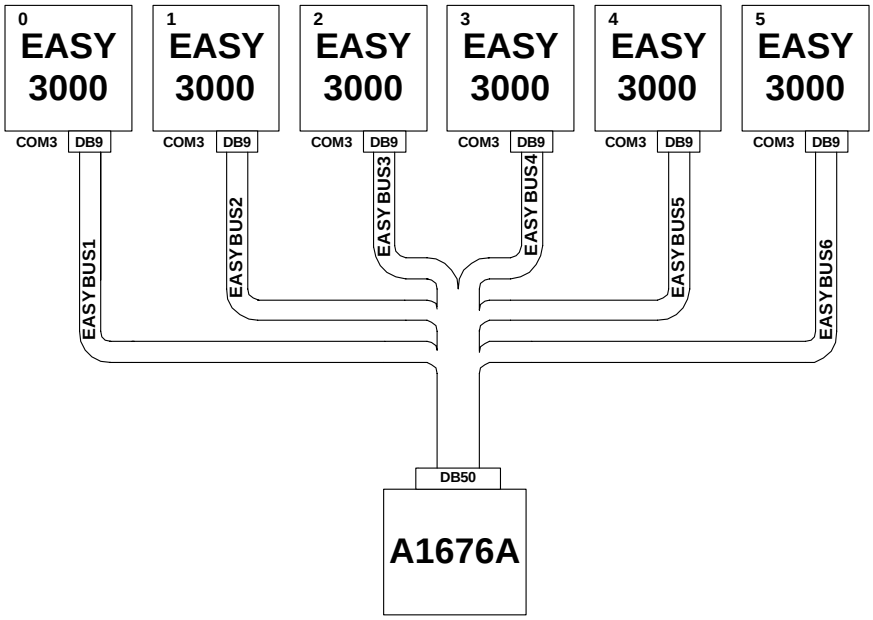

Fig. 3.5 – Connecting A1676A and the crates with split cable

The main advantage of this solution is the lower number of wires (9 for crates).
The most evident disadvantage is the more difficult manufacturing of split cables.
Note that cables must be shorter than 150 m; the Bus line does not require a termination.

3.3 48 V Power Sources

3.3.1 Mod. A3484 and A3485 AC/DC Converters

CAEN can provide 2 types of 48 V power sources (Mod. A3484 and A3485), which allow to integrate into the channels control also the management of the 48 V power supplies. The modules are implemented in a 3U / 19" Euro Rack and have Single (A3484) or Dual (A3485) 48V output. Features include local or remote control, overload protection and local or remote inhibit function. The A3484 and the A3485 are designed to work in "friendly" environment (no magnetic field and radiation).

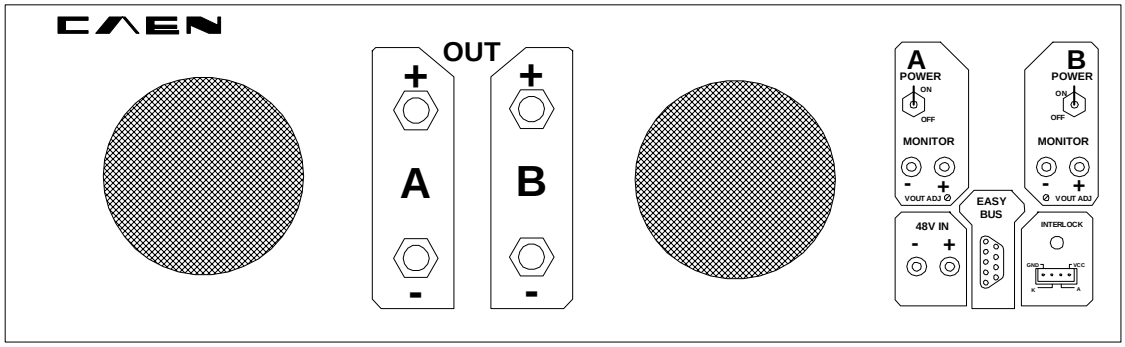

Fig. 3.6 – A3485 48 V Power Source front panel

Table 3.3 – Technical specifications of the A3484 and A3485 48 V Power Sources

Model:	A3484	A3485
Polarity:	positive	positive
AC input:	3-phase 220/400 V 50/400 Hz	3-phase 220/400 V 50/400 Hz
Output Voltage:	48 V ± 5% trimmer adjustable	48 V ± 5% trimmer adjustable
Max. Output Power:	2500 W	5000 W
Voltage Ripple:	< 100 mV pp	< 100 mV pp

3.3.2 Mod. A3486 AC/DC Converter for Hostile Areas

The CAEN Mod. A3486 is a two channel 220/400 Vac – 48 Vdc converter, which allows to integrate into the EASY channels control also the management of the 48 V power supplies. Each channel provides a 2 kW output and can be tracked in order to obtain one 4 kW output. This module is designed to work as main converter in LHC hostile areas, thus completing the EASY system. Features include local or remote control, overload protection and local or remote inhibit function.

Table 3.4 – Technical specifications of the A3486 48 V Power Source

Model:	A3486
Polarity:	positive
AC input:	3-phase 220/400 V 50/400 Hz
Output Voltage:	48 V ± 5% trimmer adjustable
Max. Output Power:	4000 W
Voltage Ripple:	< 100 mV pp

4. Safety information and installation requirements

4.1 General safety information

This section contains the fundamental safety rules for the installation and operation of the boards. Read thoroughly this section before starting any procedure of installation or operation of the product.

4.1.1 Injury Precautions

Review the following precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use the product only as specified. Only qualified personnel should perform service procedures.

Avoid Electric Overload.
To avoid electric shock or fire hazard, do not apply a voltage to a load that is outside the range specified for that load.

Avoid Electric Shock.
To avoid injury or loss of life, do not connect or disconnect cables while they are connected to a voltage source.

Do Not Operate Without Covers.
To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Do Not Operate in Wet/Damp Conditions.
To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere.
To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Do Not Operate With Suspected Failures.
If you suspect there is damage to this product, have it inspected by qualified service personnel.

4.2 Safety Terms and Symbols on the Product

These terms may appear on the product:

- **DANGER** indicates an injury hazard immediately accessible as you read the marking.
- **WARNING** indicates an injury hazard not immediately accessible as you read the marking.
- **CAUTION** indicates a hazard to property including the product.

The following symbols may appear on the product:

DANGER

High Voltage

ATTENTION

Refer to Manual

4.3 Installation

The Mod. A1676A is a single-width board for the SY1527/2527/3527 systems. At power ON the SY1527 system processor will scan all the slots in the crate to find out where the module is plugged and what kind of module it is.
The A1676A must be connected to the EASY3000 remote crates through the control lines. The control connectors are placed on the A1676A front panel and on the EASY3000 front panel.

4.4 Operating modes

The Mod. A1676A board can be controlled, either locally or remotely, through the SY1527 software interface. For details on SY1527 system operation, please refer to the User's Manual of this product.

ATTENTION

THE MOD. A1676A BOARD REQUIRES
SY1527 FIRMWARE VERSION 2.00.01 OR LATER

4.5 Output control and monitoring

It is possible, through the SY1527 system, to perform the following operations:

- **HW RESET 0..5**: all the remote channels in the relevant crate (0..5) will be turned OFF and communications reset. Settings on the remote channels will be saved
- **RECOVERY 0..5**: communications will be reset, but the remote channels in the relevant crate (0..5) will eventually remain ON. Settings on the remote channels will be saved
- **GLOBAL ON/OFF**: these commands allow to turn ON/OFF all the remote channels enabled via the channel “Pw” parameter
- **A1676A 48V**: Enable / Disable 48 V output of Branch Controller
- **UPGRADE**: Select destination of software downloading (REMOTE on remote board/ LOCAL on A1676A controller)
- **REL**: Monitor board firmware release

4.6 Interlock operation

PASSIVE INTERLOCK: it is necessary to short circuit pin 1 with pin 2 and pin 3 with pin 4.
ACTIVE INTERLOCK: it is necessary to send a TTL level between pin 2 and pin 3, leaving pin 1 and pin 4 disconnected.